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EUROPEAN PATENT APPLICATION

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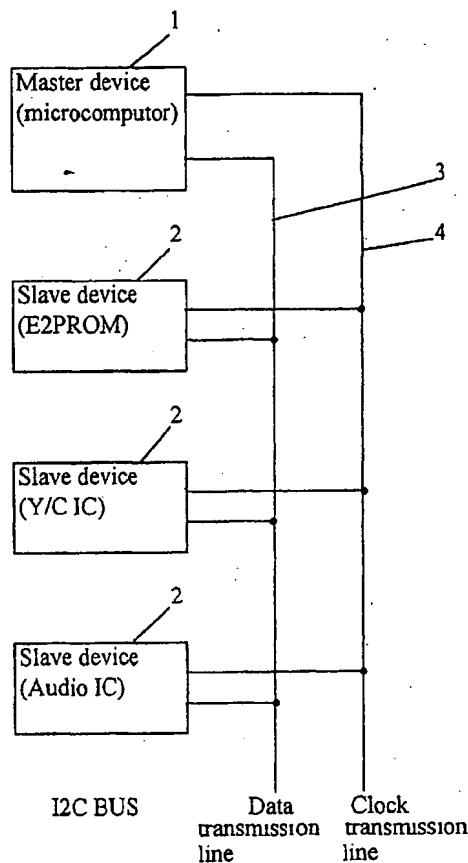
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(54) Data transfer system

(57) A data transfer system is provided for preventing a slave device from operating erroneously or running out of control on resuming communication after communication is interrupted due to the occurrence of abnormal circumstances such as a power failure and the like, wherein a master device transmits a stop condition to the slave device for terminating communication and performs a power failure-processing task when abnormal circumstances such as a power failure or a momentary power failure occurs, and transmits a start condition for reestablishing communication after transmitting a stop condition to the slave device, and the slave device terminates communication on receipt of either stop condition and reestablishes communication on receipt of a start condition.

FIG.1



Description

BACKGROUND OF THE INVENTION

[0001] The present invention relates to a data transfer system for transferring data by transmitting data bi-directionally between a master device and a slave device connected with each other by a bus line such as an I2C bus.

[0002] Such a data transfer system using an I2C (Inter-Integrated Circuit) bus connected between a master device and a slave device is described in Japanese Patent Application laid open under No. 9-265436. Such a data transfer system comprises a master device such as a microcomputer and a plurality of slave devices such as a nonvolatile memory, IC, etc. that are connected with each other by two bus lines, namely a SDA line (a data transmission line) and a SCL line (a clock transmission line).

[0003] As shown in Fig. 3, a data transfer starts when a start condition S, i.e. a start condition of data transfer is transmitted from a master device to a designated one of slave devices. The master device generates clock signals and transfers data. When a stop condition P, i.e. a stop condition of data transfer, is transmitted from the master device, data communication is stopped. Transferred data are formatted as shown in Fig. 3 (c).

[0004] In case a power failure or a momentary power failure occurs when data communication is made between the master device and the slave device, the operation of the master device and the slave device is stopped due to an interruption of power supply, and the communication is suspended just as it is. The master device also ceases to communicate in an abnormal state such as influences of disturbances, malfunctions and the like.

[0005] When a power failure or a momentary power failure is recovered and a power supply is reestablished, or an abnormal termination is reset to start, the master device becomes operable. In this case, the master device transmits a start condition to the slave device without taking into account the conditions of the slave device and the communication is commenced therebetween. When the communication cannot be commenced, some trials are repeated.

[0006] The master device commands a termination of operation immediately responding a power failure or a momentary power failure to shutdown the operation as a power failure-processing task. The slave devices, however, do not perform such a power failure-processing task. Furthermore, there exists such a slave device that can operate with a lower power supply voltage and a slave device stops to operate under quite a lower power supply voltage compared with the master device.

[0007] Accordingly, even when the master device ceases to operate due to an interruption of a power supply, a slave device still continues to operate until a power supply voltage decreases to some degrees. In case a

momentary power failure is recovered during this period, the master device starts to operate and commences communication. As the operation of a slave device is not suspended, the slave device determines that communication

5 is still continued, and the slave device does not operate to terminate communication. Consequently, it is likely that the slave device makes an erroneous judgment on data transferred by the resumed communication. Thus, there occur such problems that data stored in the slave device are rewritten by mistake, or that the slave device operates on the basis of mistaken data and finally runs out of control.

[0008] Furthermore, it is likely that the resumed communication becomes unstable due to noises caused by an interruption or recovery of a power supply and the slave device erroneously recognizes the noises as data, and consequently the slave device operates erroneously.

[0009] A stable operation can be ensured, even in a power interruption, by adding a back-up circuit for stabilizing a power supply source. However, such a measure requires a circuit design suitable for a system and increases the number of parts, which results in an increase of manufacturing costs.

SUMMARY OF THE INVENTION

[0010] It is, therefore, an object of the present invention to provide a data transfer system, which can make 30 a stable communication without causing erroneous operations when a communication is resumed after suspension due to an abnormal state such as a power failure.

[0011] The present invention provides a data transfer 35 system for transferring data by communicating between a master device and a slave device, wherein the master device is provided with a terminating means which transmits signals for terminating communication to the slave device in case of suspension of communication due to the occurrence of abnormal circumstances and a commencing means which transmits signals for commencing communication, on resuming communication, to the slave device after transmitting signals for terminating communication.

[0012] Abnormal circumstances may include a power failure, a momentary power failure, a hung-up or the like. For example, in case a power supply to the respective devices is interrupted due to a power failure or a momentary power failure during communication, the master device, prior to conducting a power failure-processing task, transmits signals for terminating communication to the slave device, and transmits signals for commencing communication, on resuming communication subsequent to the recovery of the power supply, to the slave device after transmitting signals for terminating communication.

[0013] The master device transmits signals for terminating communication several times to the slave device

until the communication is resumed after the communication is suspended due to the occurrence of abnormal circumstances.

[0014] Thus, the master device transmits signals for terminating communication when communication is suspended, and further transmits signals for terminating communication prior to commencing communication. With such an arrangement, the slave device can receive either of the above signals for terminating communication without fail prior to receiving signals for commencing communication.

[0015] In case the slave device is still in operation at the time of the occurrence of abnormal circumstances, the slave device can receive signals for terminating communication and terminate communication normally. In case the slave device is not in operation or in transit, the slave device cannot receive signals from the master device. In this case, the slave device becomes operable when abnormal circumstances are resolved to be normal and likely recognizes that communication is still continued. As a result, the slave device operates erroneously on the basis of mistaken data and runs out of control. The slave device, however, receives signals for terminating communication from the master device as mentioned above, and then the slave device can once terminate communication. By receiving signals for commencing communication, the slave device can operate to communicate regularly.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016]

Fig. 1 is a block diagram showing a data transfer system according to the present invention;

Fig. 2 is a flow chart showing the operation of the master device in case of the occurrence of abnormal circumstances; and

Fig. 3 is a format at the time when I2C bus transfers data, wherein (a) depicts data in a data transmission line; (b) depicts a clock in a clock transmission line; and (c) depicts a data array.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0017] One embodiment of the data transfer system according to the present invention is shown in Fig. 1. As in the case of a conventional system employing an I2C bus, a master device 1 consisted of a microcomputer and a plurality of slave devices 2 are connected through a data transmission line 3 and a clock transmission line 4. This data transfer system is applied to video equipments such as TV, VCR, DVD and the like. The slave devices 2 are a nonvolatile memory (E2PROM), Y/C IC, audio IC, chroma IC, switch IC and the like.

[0018] The master device 1 has a terminating function which transmits a stop condition as signals for terminat-

ing communication to the slave devices in order to terminate communication at the time of the occurrence of abnormal circumstances during communication, and has a resuming function which transmits a start condition as signals for resuming communication to the slave devices 2 after transmitting a stop condition at the time abnormal circumstances are resolved and communication is resumed.

[0019] Next, the operation at the time of occurrence of abnormal circumstances will be explained in accordance with the accompanying Fig. 2. The master device 1 detects variations of a power source voltage, and determines that an abnormal circumstance such as a power failure, a momentary power failure and the like occurs when the power source voltage decreases than a predetermined value. Subsequently, the master device 1 transmits a stop condition as I2C bus data to the slave device in transit, and terminates communication. Thereafter a power failure-processing task is implemented to suspend operation.

[0020] Although a power supply is interrupted due to a power failure and the like, the master device 1 receives an auxiliary power from a condenser and the like for performing a power failure-processing task. So, the master device 1 can transmit a stop condition even after the occurrence of a power failure and the like. A stop condition is also transmitted to terminate communication when the master device 1 is suspended due to the occurrence of some abnormal accidents.

[0021] The slave device 2 operates to suspend communication on receipt of the stop condition, thereby ensuring that a data transfer suspended by the master device 1 is not continued at the slave device 2.

[0022] Although a power voltage is gradually decreased due to an interruption of power supply, the slave device 2 is operable for a certain period after the occurrence of a power failure since a power supply voltage for stopping the slave device is considerably low. Accordingly, the slave device 2 can receive the stop condition from the master device 1 within this period.

[0023] When a power supply is resumed after resolving a power failure, the master device 1 detects a power voltage and determines that a normal state is recovered, and then starts to operate. In case the master device 1 is suspended due to the occurrence of abnormal circumstances, the operation is resumed by inputting reset signals. After waiting for a certain period (3 to 4 seconds) until the operation becomes stable, communication is resumed. A start condition is transmitted after transmitting a stop condition as I2C bus data to the slave device 2 with which communication is made before a power failure occurs. Thereafter, a regular processing is conducted. In case the master device is reset, data are read out from memories before conducting a regular processing.

[0024] When receiving a stop condition one more time, the slave device 2 operates to suspend communication again for enhancing certainty and security. Then communication is resumed on receipt of a start condi-

tion. In case the slave device 2 is arranged to detect the suspension of communication by receiving a first stop condition, the slave device 2 can determine that communication is terminated even if the slave device 2 receives again a stop condition after a recovery of a power supply or a reset operation, so that the slave device can disregard the stop condition and does not operate to suspend. Accordingly, in case a start condition is transmitted immediately after a stop condition is transmitted, the slave device 2 is ready to receive transmission and starts to communicate at once.

[0025] Due to the occurrence of an abnormal circumstance, the slave device 2 cannot occasionally receive a stop condition transmitted before communication is suspended. In this case, the slave device 2 determines that communication is continued after a recovery of a power supply or a reset operation, and tries to operate erroneously on the basis of the data transmitted before a power failure occurs. In case the master device 1 transmits a stop condition to the slave device 2 one more time, the slave device 2 can stop communication once on receipt of the stop condition. The slave device 2 takes the suspended data invalid and operates on the basis of data newly transferred. The stop condition may be used as one of reset signals, so that the slave device 2 erroneously operated can be reset by receiving the stop condition to operate normally.

[0026] The present invention is not limited to the above-described specific embodiments but is subject to various changes and modifications. For example, the present data transfer system may be applied to communication using bus lines other than an I2C bus. Furthermore, in case a slave device starts slowly after a recovery of a power supply or a reset operation and cannot receive a stop condition transmitted from the master device, a stop condition may be transmitted several times prior to transmission of a start condition.

[0027] Further, signals for terminating communication, transmitted from the master device to the slave device, may be used for one of reset signals. Also, signals for terminating communication, transmitted in case of the occurrence of abnormal circumstances, may be used for a stop condition, and signals for terminating communication, transmitted when abnormal circumstances are resolved, may be used for one of reset signals. By such arrangements, the slave device can be recovered from such conditions as erroneous operations and running out of control to the normal conditions.

[0028] As apparent from the above described explanation, the slave device can be informed without fail that the master device stops to communicate due to the occurrence of abnormal circumstances and does not make erroneous judgments of data, so that erroneous rewriting of data and running out of control are prevented.

[0029] As the slave device ceases to communicate without fail, it is free of influence from noises caused by a shutdown of a power source or an input of power supply. Therefore, the slave device does not recognize nois-

es as data and operate erroneously, and so communication becomes stable. A backup circuit to be used for a power failure is not required, but a simple software processing is only required to cope with the occurrence of abnormal circumstances, so that the manufacturing costs does not increase.

Claims

1. A data transfer system for transferring data by communicating between a master device and a slave device, wherein said master device is provided with a terminating means which transmits signals for terminating communication to said slave device in case of suspension of communication due to the occurrence of abnormal circumstances and a commencing means which transmits signals for commencing communication, on resuming communication, to said slave device after transmitting signals for terminating communication.
2. A data transfer system for transferring data by communicating between a master device and a slave device, wherein said master device is provided with a terminating means which transmits signals for terminating communication to said slave device prior to performing a power failure-processing task in case of interruption of a power supply to said slave device during communication and a commencing means which transmits signals for commencing communication to said slave device after transmitting signals for terminating communication to said slave device on resuming communication after a power supply is recovered.
3. A data transfer system for transferring data by communicating between a master device and a slave device, wherein said master device is provided with a terminating means which transmits signals several times for terminating communication to the slave device until communication is resumed after being suspended due to the occurrence of abnormal circumstances.

FIG.1

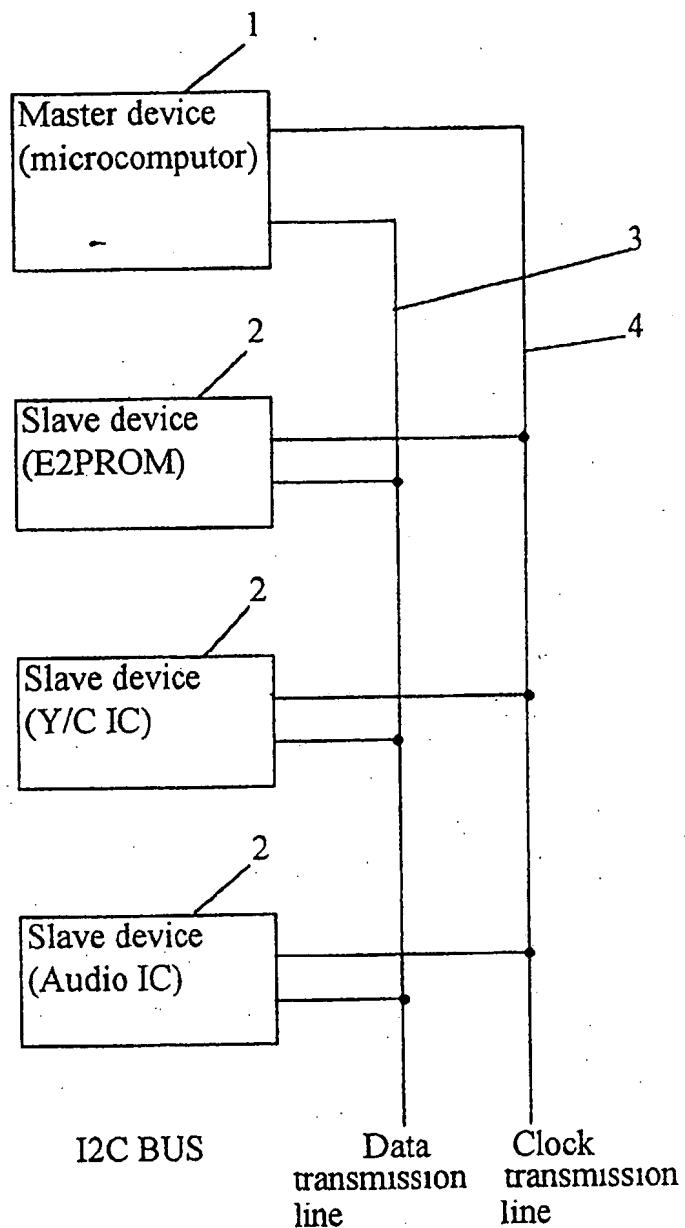


FIG.2

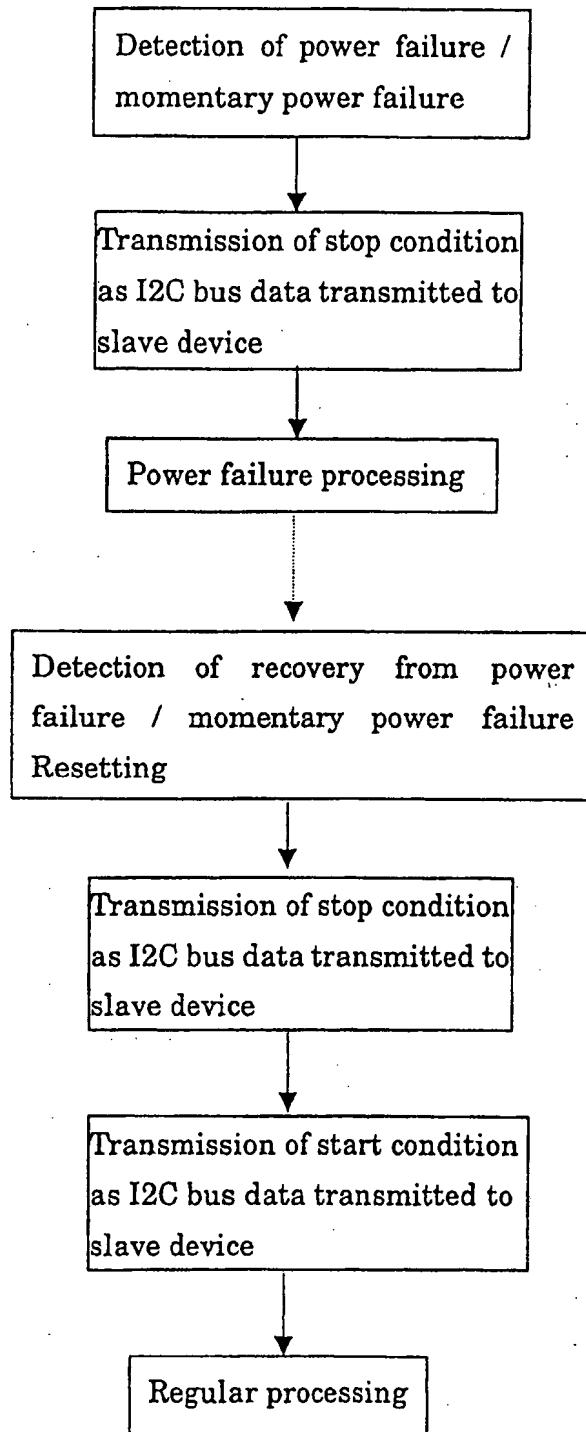
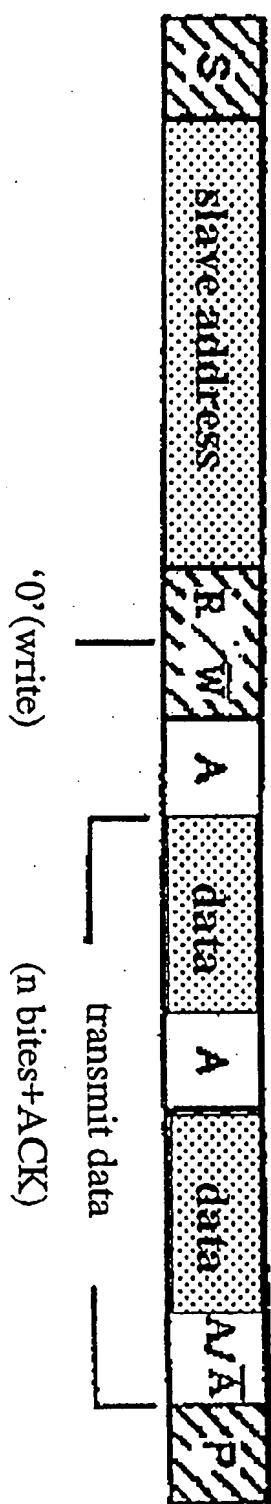
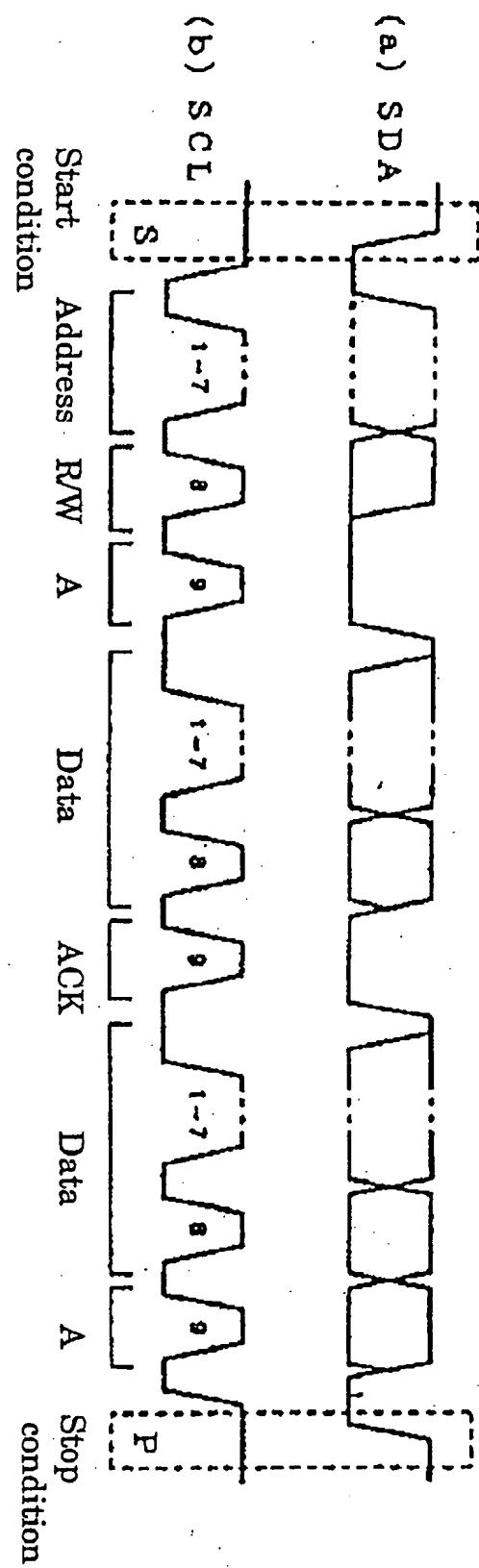


FIG. 3



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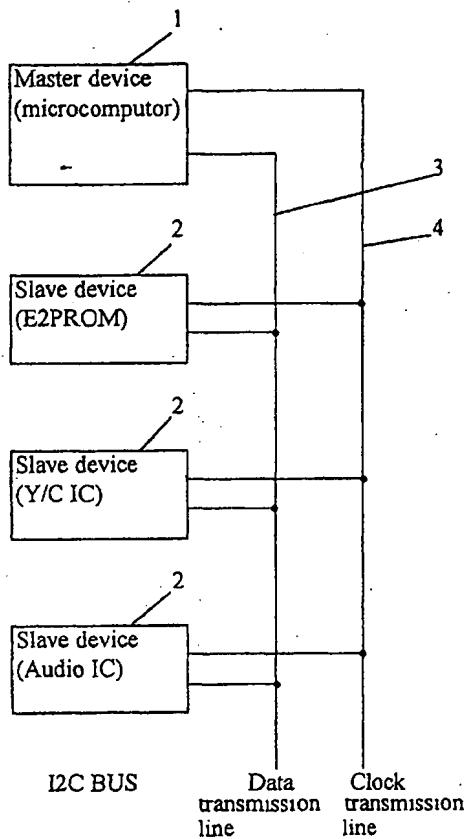
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FIG.1



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European Patent
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EUROPEAN SEARCH REPORT

Application Number
EP 03 25 2415

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	US 6 032 178 A (ERDMANN MICHAEL ET AL) 29 February 2000 (2000-02-29) * column 3, line 7 - line 12; figure 3 * * column 4, line 61 - line 63; figure 1 * -----	1,2	G06F13/42
A	US 4 689 740 A (MOELANDS ADRIANUS P M M ET AL) 25 August 1987 (1987-08-25) * the whole document *	1,2	
A	US 4 811 015 A (ABE NORIYUKI ET AL) 7 March 1989 (1989-03-07) * the whole document *	1,2	
A	WINFIELD J: "POWER-FAIL DETECTOR USES CHIP'S STANDBY MODE" ELECTRONICS, VNU BUSINESS PUBLICATIONS, NEW YORK, US, vol. 54, no. 10, 1 May 1981 (1981-05-01), page 151,153, XP000719246 ISSN: 0883-4989 * the whole document *	1,2	
A	US 4 433 391 A (POTASH HANAN) 21 February 1984 (1984-02-21) * column 5, line 44 - line 63 *	3	G06F
A	US 5 619 544 A (DIMARCO MATTHEW J ET AL) 8 April 1997 (1997-04-08) * abstract *	3	
<p>The present search report has been drawn up for all claims</p>			
Place of search	Date of completion of the search	Examiner	
Munich	27 May 2004	Sentier, L	
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document			
T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			



European Patent
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Application Number

EP 03 25 2415

CLAIMS INCURRING FEES

The present European patent application comprised at the time of filing more than ten claims.

- Only part of the claims have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims and for those claims for which claims fees have been paid, namely claim(s):

- No claims fees have been paid within the prescribed time limit. The present European search report has been drawn up for the first ten claims.

LACK OF UNITY OF INVENTION

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

see sheet B

- All further search fees have been paid within the fixed time limit. The present European search report has been drawn up for all claims.

- As all searchable claims could be searched without effort justifying an additional fee, the Search Division did not invite payment of any additional fee.

- Only part of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the inventions in respect of which search fees have been paid, namely claims:

- None of the further search fees have been paid within the fixed time limit. The present European search report has been drawn up for those parts of the European patent application which relate to the invention first mentioned in the claims, namely claims:



European Patent
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LACK OF UNITY OF INVENTION
SHEET B

Application Number

EP 03 25 2415

The Search Division considers that the present European patent application does not comply with the requirements of unity of invention and relates to several inventions or groups of inventions, namely:

1. claims: 1,2

A data transfer system for transferring data by communicating between a master and a slave device, wherein said master is provided with a terminating means which transmits signals for terminating communication to said slave device in case of suspension of communication due to abnormal circumstances and a commencing means which transmits signals for commencing communication.

2. claim: 3

A data transfer system for transferring data by communicating between a master and a slave device, wherein said master is provided with a terminating means which transmits signals several times for terminating communication to said slave device and restarting said slave device.

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

EP 03 25 2415

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
 The members are as contained in the European Patent Office EDP file on
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27-05-2004

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